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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report presents an overview of technical progress, papers published, and degrees awarded under this contract.

The Joint Services Electronics Program at the Polytechnic is the core of interdisciplinary research in electronics encompassing programs in the Department of Electrical Engineering, Physics, and Chemistry under the aegis of the Weber Research Institute. The research encompassed by this program is grouped under three broad categories: Electromagnetics, Solid State Electronics, and Information Electronics.

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on
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April 1, 1985 to March 31, 1988

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WEBER RESEARCH INSTITUTE
FARMINGDALE, NY 11735-3995

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A. OVERVIEW OF CONTRACT ACTIVITIES

During this three-year contract period important administrative changes have occurred. The most important modification is the change in contract leadership. Dr. Arthur A. Oliner has resigned his position as Director of the Microwave Research Institute, and also as Director of the Joint Services Electronics Program at the Polytechnic. The new Director of both is Dr. Erich E. Kunhardt. In this same period, Prof. Saul W. Rosenthal, who has been Assistant Director, has been replaced by Dr. James T. LaTourrette, who is now Associate Director.

The Joint Services Electronics Program at the Polytechnic has historically formed the "core" or "base" of the programs within the Microwave Research Institute, and its Director was also the JSEP Lab Director most of the time. Since it is appropriate that there be a strong connection between the two responsibilities, Dr. Kunhardt is now the Director of both entities. The second modification involves the name of our JSEP Laboratory; it was changed from the Microwave Research Institute to the Weber Research Institute.

The name of our JSEP Laboratory since the program began at the Polytechnic about 30 years ago has been the Microwave Research Institute; that name was most appropriate in those early days when the bulk of the program related to electromagnetics and microwave engineering. As the scope of the program expanded over the years, consideration was given to changing the name but the original name was retained because it has gained worldwide recognition. Now that the research institute has new leadership and the program is expanding in new directions, it has become timely to change the name. The choice of the name, Weber Research Institute, is singularly appropriate in view of Dr. E. Weber's fundamental roles as the founder of the research institute and its director throughout its formative years.

Along with the change in the Director and the change in the name of our research institute, there has been a shift in the relative support given to different technical areas and the infusion of new personnel into the program.

In accordance with guidance from the TCC, we phased out the two Information Electronics research units by ramping down their funding each year in linear fashion. With the money saved by the ramping down process, we supported and encouraged two new exploratory starts. It is important to note that all three names involved in those new starts corresponded to new (and younger) faculty members.

Our approach to the infusion of new and younger faculty members into the program is based on the view that those faculty members who have been in the program for some time should provide the guidance and extension of competence necessary for the program to retain its present strengths and to gain new ones which build on those. The older faculty members would later be

phased out to enable the program to move more easily into new and more exciting technical areas.

This approach was begun during the latter half of the present contract and is being further implemented in the successor contract. During the second half of the present contract, four new and younger faculty members were introduced into the program.

The three major technical areas of our program are designated as Electromagnetics, Solid State, and Information Electronics. We are maintaining our activities in electromagnetics, which has been a traditional strength at the Polytechnic. We are also phasing out our projects in information electronics and employing that funding to improve the portion of our program on solid state, with stress on field-particle interactions.

Among the major accomplishments during this three-year contract period we may cite the work on the optical bistability of microparticles, including the first theoretical prediction of such bistability in Rayleigh-sized microparticles, and the experimental demonstration of the effect on a single micron-sized aerosol particle. This work may represent the first step in the utilization of a microparticle as an optical memory element, which could become the smallest and fastest such element conceived so far. This topic will be pursued further on the successor contract, where difficult nonlinear calculations must be made. Another study to be carried out on the successor contract, and involving nonlinear effects, concerns some interesting new beam-field interactions in nonlinear thin films. This study is an outgrowth of accomplishments on our present program, where a unified theory of electromagnetic beams incident on thin-film layers has shown that a set of rather surprising non-specular effects can occur, and that the scattered beams can undergo previously unexpected lateral, focal and angular shifts when the incident beam is phased-matched to a leaky wave that can be supported by the layer configuration.

Another important accomplishment on the present program that relates to leaky waves is the demonstration that such waves play an unexpectedly important role in monolithic microwave integrated circuits (MMICs), in millimeter-wave integrated circuits, and in interconnects in very high-speed computers. Leaky waves are the source of hitherto unexpected and poorly understood cross-talk and power-coupling effects that can produce havoc in systems based on these circuits. This study is not being continued on the successor contract. Another study in electromagnetics on the present contract has resulted in a thorough understanding of the interrelations between rays and modes, and waves and spectra, leading to a series of accomplishments that range from improvements in GTD theory as applied to complex resonances in target identification to a better analysis of "focus wave modes." The general approach developed by this study will be applied in the successor contract to wide-band interactions in large aperture-coupled enclosures.

Many other significant accomplishments were achieved in all three technical areas of the program, but only one other example will be given here. It is in the area of laser-induced MOCVD, where IR is employed rather than UV. The accomplishment is that success was obtained in producing coatings on a substrate at lower temperatures and at distances of several centimeters from the laser beam. The success followed a series of elaborate experiments that improved fundamental understanding; the new step was to raise the gas temperature substantially, producing unstable species of polysilanes that then coated out at very low substrate temperatures. This work will not be continued on the successor contract.

B. LIST OF PRINCIPAL INVESTIGATORS

The principal investigators who have guided research projects under this contract are:

S. Arnold
L.B. Felsen
H.J. Juretschke
E.E. Kunhardt
L. Kurz
K.M. Leung
A.A. Oliner
A. Papoulis
S.U. Pillai
B. Post
P.S. Riseborough
G. Schaefer
D.M. Schleich
T. Tamir

C. DEGREES AWARDED

Advisor	
S. Arnold	L.M. Folan
	E.K. Murphy
L.B. Felsen	P. Einziger
	E. Heymann
	A.H. Kamel
	I-T. Lu
	H. Shirai
H.J. Juretschke	H.E. Gaballa
L. Kurz	E.S.H. Chang
	A. Elrefaie
	A. Said
A.A. Oliner	T.L. Dong
	M. Guglielmi
	K.S. Lee
	J-S. Myung
	A. Sanchez
	M.J. Shiau
T. Tamir	C.W. Hsue
	F.Y. Kou
	V.S. Shah

D. LIST OF PUBLICATIONS (JSEP)

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